Calculation of Cosmic Ray Induced Single Event Upsets
PROGRAM CRUP, COSMIC RAY UPSET PROGRAM
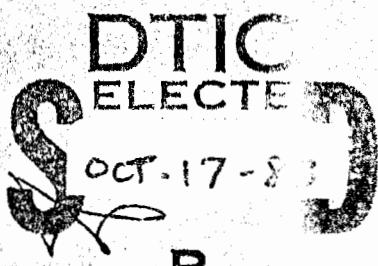
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Radiation Survivability Branch
Condensed Matter and Radiation Sciences Division

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report documents PROGRAM CRUP, COSMIC RAY UPSET PROGRAM. The computer program calculates cosmic ray induced single-event error rates in microelectronic circuits exposed to several representative cosmic-ray environments.

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CONTENTS

Calculation of Cosmic Ray Induced Single Event Upsets:

PROGRAM CRUP, COSMIC RAY UPSET PROGRAM

I.   INTRODUCTION

Since the publication of our calculations on cosmic ray induced single event upsets in cosmic ray environments,[1,2] interest has been expressed within the single event community for an export version of the computer program. The version of the program used for the calculations reported in the above mentioned references was run on the SEL 32-55 Oata Acquisition Computer at the NRL Cyclotron. An export version of this program has been developed. The calculational method employed is the same as described in Refs. (1) and (2). Some small changes in the details of the calculational method, and an update in the 90 percent worst case environment furnished with this program are described. This export version does not have the scaling features contained in the original program, and it has been rewritten to be independent of the file structure of the SEL computer. The revised program runs correctly on the SEL 32-55. The intent of this documentation is to furnish sufficient information for a reasonably experienced FORTRAN programmer to convert the program to run on his computer. The export tape has been translated from the 7 track magnetic tape generated at the SEL computer to the more universally readable 9 track tape in a DEC VAX-11 readable format.

II. PROGRAM ORGANIZATION

The export tape contains two files. The first file is the complete FORTRAN program, ready for compilation. The second file, intended to be read in as data upon program execution, contains three cosmic ray environments in the form of differential LET spectra, written as card images. The first two environments in the second file are the solar minimum, and the solar maximum environments, respectively, identical to the environments used for the calculations reported in Refs. (1) and (2). The third environment, the 90 percent worst case environment, is a revised LET spectrum, based on new data that was furnished to us by J.H. Adams, Jr. of the NRL Space Science Oivision, since publication of Refs. (1) and (2). It should be remarked that the "90 percent worst case" in Ref. (1) is identical to the "10 percent worst case" discussed in Ref. (2).

Upon execution of the program, the three differential LET spectra are read into three sets of pre-dimensioned arrays, one set for each of the spectra. Each set consists of an alphanumeric identifier of 20 words, with an associated two dimensional array for the data, 2 x 1000 words. The first record for any LET spectrum is a title, up to 80 characters, followed by 250

records, each containing four pairs of 10 character fields, each pair being a value of the LET spectrum, followed by the corresponding value of LET. The alphanumeric identifier and the data pairs for each spectrum are read into the arrays identified in Table I, with the index 1 on the two dimensional array corresponding to the value of LET, and the index 2 corresponding to the corresponding value for the differential LET spectrum.

TABLE I

Array Identifications

Index	Spectrum	Alphanumeric Identifier	LET Spectrum
1	Solar Minimum	TMIN(20)	SOLMIN(2,1000)
2	Solar Maximun	TMAX(20)	SOLMAX(2,1000)
3	90 Percent Worst Case	TWORST(20)	WORST(2,1000)

The program is designed to be run in an interactive mode from a terminal. The first prompt message asks for the cell dimensions: ℓ,w,h, with $\ell > w \geq h$. Then, following the terminology in Ref. (1), values for the critical energy in MeV and the error conversion factor are requested. The next prompt message requests an index which identifies an environment for the particular calculation. These indices are tabulated in Table I. There is also an option that permits printout of the integral chord-length distribution and the selected LET spectrum. Upon completion of the calculation, the result is displayed on the terminal screen and stored for printout upon exit from the program. Arrays for storage of results with associated input parameters exist to store up to twenty results. Entering a carriage return at the first prompt message, which asks for the cell dimensions, causes the program to terminate with printout of the stored results.

A brief description of the subprograms is given in section III, and a complete listing of the program is contained in Appendix B. The subroutines M:IOEX, M:BLOCK, and INIT which occur early in the main program are specific to the particular SEL computer installation used for this work. These subroutines can be eliminated for most installations. Subroutine M:IOEX take care of a graceful exit if the program bombs out during execution. Subroutine M:BLOCK tells the system which SEL convention is used for data on logical unit 1, the magnetic tape. The function of INIT is to alert logical unit 5, the terminal used in an interactive mode in the program.

The numerical integration, utilizing a simple trapezoidal technique, is done in the body of the main program. Interpolation between values of the rapidly varying LET spectrum has generally been avoided by varying the integration intervals to agree with the tabular values of LET,

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except for the case of the first integration interval which starts at $L = L_0$, the minimum value of LET which produces an event. In this case, a logarithmic interpolation technique is used. The integral chord-length distribution, $C(\ell)$, is calculated once and then stored in TABLE (2,512). During the calculation, required values of $C(\ell)$ are obtained by interpolation.

III. BRIEF DESCRIPTION OF SUBPROGRAMS

A brief description of the subprograms is given in this section. These descriptions should enable a serious user, who makes the effort, to find his way through the program for revision or independent use of the subprograms.

A. SUBROUTINE C1(XL,W,H,NTABLE).

This subroutine computes the integral chord-length distribution, $C(S)$, storing the results in TABLE(2,512). TABLE(1,N) contains a chord length, with the corresponding value of $C(S)$ stored in TABLE(2,N). The computations are performed for NTABLE values for each segment of the chord-length distribution. A segment is considered to be the portion of $C(S)$ between adjacent singularities in $C(S)$. The singularities are discussed in Appendix A and in the discussion of SUBROUTINE SING(XL,W,H). It should be noted that the tabulated values of $C(S)$ are for equally spaced values of S within each segment only, but each segment will generally have different spacing of the tabulated values.

The integral chord-length distribution was calculated in Ref. (1) by numerical integration of the expression for the differential chord-length distribution published by Pickel and Blandford.[3] Since publication of Ref. (1), Warren Bendel of NRL has pointed out to me that the differential chord-length distribution can be integrated in closed form. The closed form approach has been used here. The analytic expressions for the indefinite integrals, due to Bendel, are given in Appendix A.

Subroutines SING and PERMSUM are called by this subroutine.

B. SUBROUTINE SING(XL,W,H).

This subroutine finds the singularities in $C(S)$ and arranges them monotonically in ascending order for insertion into SLIM(B). SLIM will contain NLIM entries, NLIM<B. The array SLIM contains the boundaries of the segments of $C(S)$. For this reason, SLIM(1) is set equal to zero; the next entries contain the singularities; and SLIM(NLIM) contains the maximum chord length for the particular cell.

C. FUNCTION F1(S,X,Y,Z).
FUNCTION F2(S,X,Y,Z).
FUNCTION F3(S,X,Y,Z).

Functions F1, F2, F3 evaluate Eqs. (6), (7), and (B), respectively, of Appendix A. Checks are made that the value of S is within the limits of validity for the particular function.

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D. FUNCTION PERMSUM(S,XL,W,H).

This function sums over the permutations of x,y,z indicated in Eq. (1) of Appendix A and in Eq. (A-8) of Ref. (3). An appropriate choice between F1, F2, and F3 is made, depending on the relationship between S, X, Y, and Z.

E. SUBROUTINE READIN(A,T).

This utility subroutine reads the LET spectra from the source magnetic tape into the assigned arrays listed in Table I.

F. SUBROUTINE TRANSFER(T1,P1,T2,P2).

This subroutine transfers the selected LET spectrum from the arrays represented by T2 and P2 to the working arrays T1 and P1.

G. SUBROUTINE LAG(X1,X2,X3,X4,Y1,Y2,Y3,Y4,X,Y).

This is a four point Lagrangian interpolation routine. The values of the independent variable are known at X1, X2, X3, and X4; with associated values of the dependent variable at Y1, Y2, Y3, and Y4. This subroutine finds the value of Y at the value of the independent variable, X, and puts the value in Y.

H. FUNCTION   FINTERP(TABLE,NTABLE,X)
   FUNCTION   FINTERP1(TABLE,NMIN,NMAX,X)

FINTERP is a function designed for four point Lagrangian interpolation in a two dimensional array TABLE(2,NTABLE), where TABLE(1,N) contains the independent variable, and TABLE(2,N) contains the dependent variable. X is the value of the independent variable for interpolation.

FINTERP1 is a slightly modified version of FINTERP which was written to take care of a special situation when the revised 90 percent worst case LET spectrum was delivered to us with zeroes at the beginning and at the end of the array. Instead of having a full table of NTABLE values as in the case of FINTERP, FINTERP1 uses values of TABLE(1,N) and TABLE(2,N) for N between NMIN and NMAX, where the array contains non zero values of the dependent variable.

FINTERP and FINTERP1 call on SUBROUTINE LAG.

IV. ACKNOWLEDGEMENTS

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References

1. P. Shapiro and E.L. Petersen, "Calculation of Cosmic Ray Induced Soft Upsets and Scaling in VLSI Devices," NRL Memorandum Report 4864, August 26, 1982.

2. E.L. Petersen, P. Shapiro, J.H. Adams, Jr., and E.A. Burke, "Calculation of Cosmic Ray Induced Soft Upsets and Scaling in VLSI Devices," IEEE Trans. Nucl. Sci. NS-29, 2055 (1982).

3. J.C. Pickel and J.T. Blandford, Jr., "Cosmic Ray Induced Errors in MOS Devices," IEEE Trans. Nucl. Sci. NS-27, 1006 (1980). Erratum, IEEE Trans. Nucl. Sci. NS-29, 2122 (1982).

APPENDIX A

INTEGRAL CHORD-LENGTH DISTRIBUTION

The analytic integration of the expression for the differential chord length-distribution due to Petroff, and reported in Ref. (3), was furnished to me by Warren Bendel of NRL.

We consider a rectangular parallelepiped of dimensions ℓ, w, and h.

The normalized differential distribution function for pathlength S is called F and integrated to unity. It is given by

$$(3\pi/4)(\ell w + \ell h + wh) \, F(S,\ell,w,h) = \sum_6 N(S,x,y,z) \tag{1}$$

where the sum is over the six permutations of (ℓ,w,h) as (x,y,z). In each case, $N + N_0$ is three times the quantity g of Petroff.

The expression for N has three forms, depending upon the value of S relative to z and $(x^2 + z^2)^{1/2}$. As these expressions are complicated, we introduce symbols (below) for certain functions of the dimensions. We also define, with capital letters, two relationships with pathlength.

Symbols

$$r^2 = x^2 + y^2 + z^2$$

$$t^2 = x^2 + z^2$$

$$k = (x^2 - y^2/(x^2 + y^2)^{1/2}$$

$$m = y^2/(x^2 + y^2)$$

$$v = 3\,xyz^2$$

$$p^2 = S^2 - z^2$$

$$Q^2 = S^2 - x^2 - z^2$$

A few terms are common to all three regions of S and therefore can be treated uniformly for $0 \le S \le r$. These terms are

$$N_0 = 2x^2\left[\frac{y^2}{t^2 r} - \frac{2}{r} + \frac{r}{x^2 + y^2}\right] = \frac{2}{r}\left[\frac{x^2 y^2}{x^2 + z^2} + \frac{x^2 z^2}{x^2 + y^2} - x^2\right] \tag{2}$$

Summing over all six permutations, one finds that

$$\sum_6 N_0 = 0$$

and thus N_0 may be omitted (as it was) from Eq. (1).

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For the first region, where $0 \leq S < z$, N is given by

$$N_1 = A_1 + B_1 S \tag{3}$$

where $A_1 = (2/t)(x^2 - z^2) + 2mZ$ and $B_1 = -(3xy/2rt)^2$. $\tag{4}$

If $z \leq S < t$, the equation is

$$N_2 = A_2 + B_2 S + C_2/S^3 + (k - x)\frac{P}{S}(2 + z^2/S^2)$$

where $A_2 = (2/t)(x^2 z^2)$, $B_2 = (9/4)(m-(xy/rt)^2)$, and $C_2 = v \tan^{-1}(y/x) - mz^4/4$.

Finally, for $t \leq S \leq r$, Petroff's equation reduces to

$$N_3 = B_3 S + C_3/S^3 + k\frac{P}{S}(2 + z^2/S^2) + yz^2\frac{Q}{S}(2/t^2 + 1/S^2) - (v/S^3)\cos^{-1}(x/P) \tag{5}$$

where $B_3 = -\frac{9x^2}{4}\left[\frac{1}{x^2 + y^2} - \frac{1}{r^2}\right]$ and $C_3 = \frac{x^2 z^2}{4}\left[\frac{z^2}{x^2 + y^2} - 3\right] + v\tan^{-1}(y/x)$.

Integration of N_1, N_2, and N_3 yields:

$$I_1 = \int N_1\, dS = A_1 S + B_1 S^2/2 \tag{6}$$

$$I_2 = \int N_2\, dS = A_2 S + B_2 S^2/2 - C_2/2S^2 + (k - x)E \tag{7}$$

where $E = P(2 - z^2/2S^2) - (3z/2\cos^{-1}(z/S)$

$$I_3 = \int N_3\, dS = B_3 S^2/2 - C_3/2S^2 + kE$$
$$+ yz^2[Q(2/t^2 - 1/2S^2) - (3/2t)\cos^{-1}(t/S)]$$
$$- (3xy/2)\ [(P/S)^2\cos^{-1}(x/P) - (x/t)\cos^{-1}(t/S)]. \tag{8}$$

Inspection of the results of the integration indicates that there are six singularities in the calculation of C(S) if the cell dimensions are nondegenerate. The number of singularities is reduced if two or more of the cell dimensions are identical. Integration of the differential chord-length distribution is performed in segments to take into account changes in the analytic expression as a singularity is crossed. The singularities occur at $S = w, h, \ell$, $w^2 + h^2$, $w^2 + d^2$, and $h^2 + \ell^2$.

LISTING OF PROGRAM

```
$ TYPE EXPORT1.FOR;1
C*************FILE EXPORT(3/3/83)**********************
C      PROGRAM CRUP
C      PROGRAM TO CALCULATE SOFT UPSETS DUE TO COSMIC RAYS
C        REQUIRES $ASSIGN3 5=TY61    (TERMINAL)
C        REQUIRES $ASSIGN3 1=MT,SOURCE   (MAG TAPE)
C        REQUIRES $ASSIGN2 LO=SLO,2000   (LINE PRINTER)
       INTEGER FILE
       DIMENSION PHITABLE(2,1000),XLL(20),WW(20),HH(20),
      1 XLNTABLE(2,1000),TITLE(20),ERR80(20),ECRIT(20),ERCONV(20),
      2 LETF(20)
       COMMON/CL/TABLE(2,512),SLIM(8),NLIM,SOLMIN(2,1000),SOLMAX(2,1000),
      1 WORST(2,1000),TMIN(20),TMAX(20),TWORST(20)
       DATA RHO/2.33/,C3/1.25992105/,NPHI/1000/
       NCS=0
C*****SEL DEPENDENT CODING
       CALL M:IOEX($7100,$7100)
       CALL M:BLOCK('1')
       CALL INIT('5',8Z6AF00RC0,8Z00000000)
C*****SEL DEPENDENT CODING
       CALL READ IN(SOLMIN,TMIN)
       CALL READ IN(SOLMAX,TMAX)
       CALL READ IN(WORST,TWORST)
 6000 NCS=NCS+1
       IF(NCS.GT.20) GO TO 6012
       WRITE(5,8000)
       READ (5,9000) XLL(NCS),WW(NCS),HH(NCS)
       IF(XLL(NCS).EQ.0) GO TO 6010
       WRITE(5,9014)
       READ (5,9000) ECRIT(NCS),ERCONV(NCS)
 7300 WRITE (5,8002)
C      SELECT SPECTRUM
       READ(5,9001) LETF(NCS)
       WRITE (5,8001)
       READ (5,9001) NP,NPR
       IF(LETF(NCS).EQ.1) CALL TRANSFER(TITLE,PHITABLE,TMIN,SOLMIN)
       IF(LETF(NCS).EQ.2) CALL TRANSFER(TITLE,PHITABLE,TMAX,SOLMAX)
       IF(LETF(NCS).EQ.3) CALL TRANSFER(TITLE,PHITABLE,TWORST,WORST)
       IF(LETF(NCS).GT.3) GO TO 6015
       IF(LETF(NCS).EQ.0) GO TO 6015
       FILE=LETF(NCS)
       IF(NPR.EQ.0) GO TO 2002
       PRINT 9013,TITLE
       PRINT 9010
       DO 3500 I=1,250
       I1=4*I-9
       I2=I1+9
 3500 PRINT 9011,(PHITABLE(1,J),PHITABLE(2,J),J=I1,I2)
C      DETERMINE RANGE OF INDICES TO ELIMINATE ZEROES IN LET SPECTRUM
C      INDICES GO FROM L1 TO LMAX
C      DETERMINE L1
 2002 DO 2005 I=1,1000
       IF(PHITABLE(2,I).NE.0.0) GO TO 2001
 2005 CONTINUE
       PRINT 9015
       CALL EXIT
 2001 L1=I
C      DETERMINE LMAX
       NTEST=NPHI
       DO 2500 I=1,1000
```

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```fortran
      IF(PHITABLE(2,NTEST).NE.0.0) GO TO 2501
      NTEST=NTEST-1
 2500 CONTINUE
 2501 LMAX=NTEST
      DO 200 I=L1,LMAX
      XLNTABLE(1,I)=PHITABLE(1,I)
  200 XLNTABLE(2,I)=ALOG(PHITABLE(2,I))
      XL=XLL(NCS)
      W=WW(NCS)
      H=HH(NCS)
      SA=2.0*(XL*W + XL*H + W*H)
      SMAX=SQRT(XL*XL + W*W + H*H)
      OE=ECRIT(NCS)
      XLOP=OE/SMAX/RHO*1.0E4
      XNS=0
      XLMAX=PHITABLE(1,LMAX)
C     SET UP CHORD-LENGTH DISTRIBUTION
      NC=20
      CALL C1(XL,W,H,NC)
      NTABLE=(NLIM-1)*(NC-1)+1
C     OPTIONAL PRINTOUT OF C(S)
      IF(NP.EQ.0)GO TO 1551
      PRINT 9002
      PRINT 9008,XL,W,H
      PRINT 9004,(SLIM(I),I=1,NLIM)
      PRINT 9005
      NSEG=NLIM
      NCT=0
      NTT=NC-1
      DO 1100 I=1,NSEG
      IF(I.EQ.NSEG) NTT=1
      DO 1110 J=1,NTT
      NCT=NCT+1
 1110 PRINT 9006,TABLE(1,NCT),TABLE(2,NCT)
 1100 PRINT 9016
 1551 WRITE(5,9007)
      DEP=ECRIT(NCS)
      IF(XLOP.LT.PHITABLE(1,L1))XLOP=PHITABLE(1,L1)
      IF(XLOP.GT.PHITABLE(1,LMAX)) GO TO 1700
C     SPECIAL TREATMENT OF FIRST INTEGRATION INTERVAL
 2000 SUM=0
      ISTART=L1+1
      IF(XLOP.LE.PHITABLE(1,L1))GO TO 1400
      LL=L1+1
      DO 1401 K=LL,LMAX
      IF(XLOP.LE.PHITABLE(1,K)) GO TO 1402
 1401 CONTINUE
 1402 ISTART=K+1
C     SPECIAL TREATMENT OF FIRST INTEGRATION INTERVAL
      X1=XLOP
      X2=PHITABLE(1,K)
      Y1=FINTERP1(XLNTABLE,L1,LMAX,XLOP)
      Y1=EXP(Y1)
      SL=DEP/RHO/X1*1.0E4
      C11=FINTERP(TABLE,NTABLE,SL)
      Y2=PHITABLE(2,K)
      SL=DEP/RHO/X2*1.0E4
      C2=FINTERP(TABLE,NTABLE,SL)
      IF(C11.LT.0)C11=0
      IF(C2.LT.0)C2=0
```

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        SUM=(Y1*C11 + Y2*C2) *(X2-X1)
 1400 FACTOR=DEP/RHO*1.0E4
        DO 1500 J=ISTART,LMAX
        X1=PHITABLE(1,J-1)
        X2=PHITABLE(1,J)
        SL1=FACTOR/X1
        SL2=FACTOR/X2
        C11=FINTERP(TABLE,NTABLE,SL1)
        C2=FINTERP(TABLE,NTABLE,SL2)
        IF(C11.LT.0)C11=0
        IF(C2.LT.0)C2=0
        PSUM=(C2*PHITABLE(2,J) + C11*PHITABLE(2,J-1))*(X2-X1)
 1500 SUM=SUM+PSUM
C       XNS OUTPUT IN EVENTS/BIT-DAY FOR PHI PER M**2 PER SECOND
C       PER STERAD PER LET UNIT
C       ERRBD IS ERRORS/BIT-DAY
        XNS=1.3570E-7*SA        *SUM*0.5
        ERRBD(NC        ERCONV(NCS)
        WRITE(5,5         ',XL,W,H,DEP,ERCONV(NCS),ERRBD(NCS)
        GO TO 6000
C       JUMP HERE IS XLWP OUTSIDE OF RANGE OF PHI(L)
 1700 ERRBD(NCS)=0
        WRITE(5,9008)FILE,XL,W,H,DEP,ERCONV(NCS),ERRBD(NCS)
        GO TO 6000
C       PRINTOUT RESULTS
 6010 PRINT 9012
        PRINT 9007
        NCS=NCS-1
        DO 3000 I=1,NCS
 3000 PRINT 9008,LETF(I),XLL(I),WW(I),HH(I),ECRIT(I),ERCONV(I),
     1ERRBD(I)
C*****SEL DEPENDENT CODING
 7100 CALL INIT('5',8Z68F008F0,8Z0000003F)
C*****SEL DEPENDENT CODING
        CALL EXIT
 60\   WRITE(5,6011)
        GO TO 7100
 6011 FORMAT(1H0,'PROGRAM CASE TABLES EXCEEDED',/)
 6015 NCS=NCS-1
        WRITE(5,6016)
 6016 FORMAT(1X,'INCORRECT INDEX',/)
        GO TO 6000
 8000 FORMAT(1X,'ENTER L,W,H(3E11.4)',/,
     1 ' (L.GE.W.GE.H)',/,' CR TO TERMINATE PROGRAM',/)
 8001 FORMAT(1H0,'ENTER CHORD-DISTRIBUTION PRINT CONTROL,'/
     1' SPECTRUM PRINT CONTROL(2I1)',/,
     2 ' 0 FOR NO PRINT, 1 FOR PRINT',/)
 8002 FORMAT(1X,'ENTER SPECTRUM INDEX---',/,
     1 ' 1-SOLMIN',/,' 2-SOLMAX',/,' 3-90% WORST CASE',/)
 8005 FORMAT(1X,15A4)
 9000 FORMAT(6E11.4)
 9001 FORMAT(2T1)
 9002 FORMAT(1H1,'INTEGRAL CHORD-LENGTH DISTRIBUTION')
 9003 FORMAT(1H0,'L=',F7.2,5X,'W=',F7.2,5X,'H=',F7.2)
 9004 FORMAT(1H0,'SINGULARITIES AT S=',0(F7.2,1H,))
 9005 FORMAT(1H0,3X,1HS,11X,'C(S)')
 9006 FORMAT(1X,F7.2,3X,1PE9.2)
 9007 FORMAT(1H0,'LETFILE',10X,1HL,12X,1HW,12X,1HH,6X,'ECRIT',4X,
     1'ER CONV',2X,'ERRORS/BD',/)
 9008 FORMAT(6X,I1,3X,3(1PE11.4,2X),0PF7.2,2X,F5.1,4X,1PE9.2)
```

```fortran
 9009 FORMAT(1X,F7.2,3(2X,1PE11.4))
 9010 FORMAT(1H0,4(6X,1HL,0X,'PHI(L)',6X))
 9011 FORMAT(1X,4(1PE10.4,2X,1PE10.4,5X))
 9012 FORMAT(1H1)
 9013 FORMAT(1H1, 20A4)
 9014 FORMAT(1X,'ENTER ECRIT, ERROR CONVERSION FACTOR(2E11.4)',/)
 9015 FORMAT(1H0,'**NULL FILE--CHECK INPUT DATA**')
 9016 FORMAT(1H0)
      END
      FUNCTION FINTERP1(TABLE,NMIN,NMAX,X)
C     MODIFIED FOR USE WITH COSMIC2 SEPTEMBER 82
C     INTERPOLATION OVER INDICES FROM NMIN TO NMAX
C     DESIGNED TO IGNORE ZEROES IN LET SPECTRUM
C     DESIGNED FOR (NMAX-NMIN).GT.10
C     DESIGNED FOR NTABLE.GT.10
C     INTERPOLATION FUNCTION FOR DATA STORED IN TABLE(2,NMAX)
C     TABLE(1,N) IS INDEPENDENT VARIABLE
C     TABLE(2,N) IS DEPENDENT VARIABLE
C     X IS VALUE OF INDEPENDENT VARIABLE FOR EVALUATION OF FUNCTION
      DIMENSION TABLE(2,NMAX)
      T=(1.0 + 1.0E-5)*TABLE(1,NMAX)
      IF(X.LT.TABLE(1,NMIN) .OR. X.GT.T)GO TO 2000
C     COARSE GRID SEARCH
      N1=NMIN+9
      DO 500 I=N1,NAX,10
      IF(TABLE(1,I)-X) 500,600,600
  500 CONTINUE
  600 ISTART=I-9
      DO 1000 I=ISTART,NMAX
      IF(X.LE.TABLE(1,I))GO TO 1500
 1000 CONTINUE
 1500 N1=NMIN+3
      IF(I.LT.N1)I=3
      IF(I.GT.NMAX-1)    I=NMAX-1
      X1=TABLE(1,I-2)
      X2=TABLE(1,I-1)
      X3=TABLE(1,I)
      X4=TABLE(1,I+1)
      Y1=TABLE(2,I-2)
      Y2=TABLE(2,I-1)
      Y3=TABLE(2,I)
      Y4=TABLE(2,I+1)
      Y=0
      CALL LAG(X1,X2,X3,X4,Y1,Y2,Y3,Y4,X,Y)
      FINTERP1=Y
      RETURN
 2000 PRINT 2001,X
 2001 FORMAT(1H0,'FINTERP1 ERROR, X OUT OF RANGE, X=',1PE11.4)
      CALL EXIT
      END
      SUBROUTINE C1(XL,W,H,NTABLE)
C     H.LE.W.LE.XL
C     REVISED 9/82, P. SHAPIRO,NRL
C     SUM DISTRIBUTION FOR MU-RANDOMNESS
C     REQUIRES COMMON/CL/TABLE(2,512) IN  CALLING PROGRAM
C     TABLE(1,N) IS CHORD LENGTH
C     TABLE(2,N) IS CORRESPONDING SUM DISTRIBUTION
      DIMENSION FINT(7)
      COMMON/CL/TABLE(2, 512),SLIM(8),NLIM
      DATA PI/3.141593/,EPS/1.E-5/,EPS1/1.0E-6/
```

```
        FMINUS=1.0-EPS
        SMAX=SQRT(XL*XL + W*W +H*H)
        CALL SING(XL,W,H)
        NCT=(NLIM-1)*(NTABLE-1)+1
        NSEG=NLIM-1
        TABLE(1,NCT)=SMAX
        TABLE(2,NCT)=0
        NCT=1
        CNORM=1.33333333/PI/(XL*W+XL*H+W*H)
C       CHECK PARAMETERS
        IF(H.GT.W) GO TO 8001
        IF(W.GT.XL)GO TO 8001
        N=NTABLE-1
C       EVALUATE INTEGRAL OVER SEGMENTS 1 TO NSEG AND PUT IN FINT
        DO 1000 I=1,NSEG
        S2=SLIM(I+1)*FMINUS
        S1=SLIM(I)
  1000 FINT(I)=PERMSUM(S2,XL,W,H)          -PERMSUM(S1,XL,W,H)
        DO 2000 I=1,NSEG
C       COMPUTE DELTA FOR THIS SEGMENT
        DELTA=(SLIM(I+1)*FMINUS-SLIM(I))/(NTABLE-1)
C       SUM UP CONTRIBUTIONS FROM SUCCEEDING SEGMENTS
        FSUM=0
        IF(I.EQ.NSEG) GO TO 2020
        K=I+1
        DO 2010 J=K,NSEG
  2010 FSUM=FSUM + FINT(J)
  2020 S2=SLIM(I+1)*FMINUS
        FSUM=FSUM+PERMSUM(S2,XL,W,H)
        DO 2000 J=1,N
        S=SLIM(I)+(J-1)*DELTA
        TABLE(1,NCT)=S
        SUM=FSUM-PERMSUM(S,XL,W,H)
        TABLE(2,NCT)=SUM*CNORM
        IF (TABLE(2,NCT).LT.EPS1) TABLE(2,NCT)=0
        NCT=NCT+1
  2000 CONTINUE
        RETURN
C       ERROR MESSAGES
  8000 PRINT 9000
  9000 FORMAT('C1(XL,ETC) ERROR, TOO MANY STEPS'///)
        CALL EXIT
  8001 PRINT 9001,XL,W,H
  9001 FORMAT(1H0,'C1(',1PE11.4,',',1PE11.4,',',1PE11.4,') ERROR'///)
        CALL EXIT
        END
        FUNCTION F1(S,X,Y,Z)
        IF(S.GE.Z) GO TO 8000
        XSQ=X*X
        YSQ=Y*Y
        ZSQ=Z*Z
        TSQ=XSQ+ZSQ
        RSQ =TSQ+YSQ
        XM=YSQ/(XSQ+YSQ)
        T=SQRT(TSQ)
        A1=2.0/T*(XSQ-ZSQ)+2.0*XM*Z
        B1=-2.25*XSQ*YSQ/RSQ/TSQ
        F1=A1*S+0.5*B1*S*S
        RETURN
  8000 PRINT 1,S,X,Y,Z
```

```
    1 FORMAT(1H0,'F1(',1PE11.4,3(',',1PE11.4),') ERROR')
      CALL EXIT
      END
      FUNCTION F2(S,X,Y,Z)
      XSQ=X*X
      YSQ=Y*Y
      ZSQ=Z*Z
      SSQ=S*S
      TSQ=XSQ+ZSQ
      T=SQRT(TSQ)
      RSQ=TSQ+YSQ
      R=SQRT(RSQ)
      IF(S.LT.Z)      GO TO 8000
      IF(S.GE.T) GO TO 8000
      A2=2.0/T*(XSQ-ZSQ)
      XM=YSQ/(XSQ+YSQ)
      B2=2.25*(XM-XSQ*YSQ/RSQ/TSQ)
      XK=(XSQ-YSQ)/SQRT(XSQ+YSQ)
      V=3.0*X*Y*ZSQ
      C2=V*ATAN(Y/X)-XM*ZSQ*ZSQ*0.25
      P=SQRT(SSQ-ZSQ)
      W=Z/S
      IF(ABS(1.0-W).LE.1.0E-5) W=1.0
      E=P*(2.0-0.5*ZSQ/SSQ)-1.5*Z*ACOS(W)
      F2=A2*S+0.5*B2*SSQ-0.5*C2/SSQ+(XK-X)*E
      RETURN
 8000 PRINT 1,S,X,Y,Z
    1 FORMAT(1H0,'F2(',1PE11.4,3(',',1PE11.4),') ERROR')
      CALL EXIT
      END
      FUNCTION F3(S,X,Y,Z)
      SSQ=S*S
      XSQ=X*X
      YSQ=Y*Y
      ZSQ=Z*Z
      TSQ=XSQ+ZSQ
      T=SQRT(TSQ)
      IF(S.LT.T) GO TO 8000
      RSQ=TSQ+YSQ
      B3=-2.25*XSQ*(1.0/(XSQ+YSQ)-1.0/RSQ)
      V=3.0*X*Y*ZSQ
      C3=0.25*XSQ*ZSQ*(ZSQ/(XSQ+YSQ)-3.0)+V*ATAN(Y/X)
      P=SQRT(SSQ-ZSQ)
      W1=SSQ-TSQ
      IF(W1.LT.0.0)W1=0.0
      Q=SQRT(W1)
      XK=(XSQ-YSQ)/SQRT(XSQ+YSQ)
      E=P*(2.0-ZSQ*0.5/SSQ)-1.5*Z*ACOS(Z/S)
      W2=X/P
      IF(ABS(1.0-W2).LE.1.0E-4) W2=1.0
      W2=ACOS(W2)
      F3=0.5*SSQ*B3-C3*0.5/SSQ+XK*E+Y*ZSQ*(Q*(2.0/TSQ-0.5/SSQ)
    1 -1.5/T*ACOS(T/S))-1.5*X*Y*(P*P/SSQ*W2
    2 -X/T*ACOS(T/S))
      RETURN
 8000 PRINT 1,S,X,Y,Z
    1 FORMAT(1H0,'F3(',1PE11.4,3(',',1PE11.4),') ERROR')
      CALL EXIT
      END
      FUNCTION PERMSUM(S,XL,W,H)
```

```
        DIMENSION IX(6),IY(6),IZ(6),D(3)
        DATA IX/1,2,1,2,3,3/,IY/2,1,3,3,2,1/,IZ/ 3,3,2,1,1,2/
        SMAX=SQRT(XL*XL+W*W+H*H)
        PERMSUM=0
        D(1)=XL
        D(2)=W
        D(3)=H
C       THIS LOOP HANDLES PERMUTATIONS OVER X,Y,Z
        DO 1000 NP=1,6
        X=D(IX(NP))
        Y=D(IY(NP))
        Z=D(IZ(NP))
        T=SQRT(X*X+Z*Z)
        IF(S.LT.Z) GO TO 1500
        IF(S.LT.T) GO TO 1700
        IF(S.LE.SMAX) GO TO 1800
C       S.GT.SMAX
        PERMSUM=0
        RETURN
C       S.LT.Z
 1500   PERMSUM=PERMSUM+F1(S,X,Y,Z)
        GO TO 1000
C       S.GE.Z .AND. S.LT.T
 1700   PERMSUM=PERMSUM+F2(S,X,Y,Z)
        GO TO 1000
C       S.GE.T .AND. S.LT.SMAX
 1800   PERMSUM=PERMSUM+F3(S,X,Y,Z)
 1000   CONTINUE
        RETURN
        END
        SUBROUTINE SING(XL,W,H)
C       SETS UP ORDERED TABLE OF SINGULARITIES
        DIMENSION T(3)
        COMMON/CL/TABLE(2,512),SLIM(8),NLIM
        SLIM(1)=0
        SLIM(2)=H
        N=2
        IF(H.EQ.W) GO TO 100
        N=N+1
 100    SLIM(N)=W
        IF(XL.EQ.W) GO TO 200
        N=N+1
        SLIM(N)=XL
 200    NT=0
        X=SQRT(H*H+W*W)
        IF(X.EQ.XL) GO TO 250
        NT=1
        T(1)=X
 250    Y=SQRT(H*H+XL*XL)
        IF(NT.EQ.1 .AND. Y.EQ.T(1)) GO TO 300
        NT=2
        T(NT)=Y
 300    Y=SQRT(XL*XL +W*W)
        IF(Y.EQ. T(NT)) GO TO 400
        NT=NT+1
        T(NT)=Y
 400    DO 500 I=1,NT
        JF=N+I
 500    SLIM(JF)=T(I)
        NLIM=N+NT+1
```

```
      SLIM(NLIM)=SQRT(XL*XL+W*W+H*H)
C     SORT SLIM INTO ASCENDING ORDER
      DO 1000 I=1,3
      DO 1000 J=2,NLIM
      IF(SLIM(J-1).LT.SLIM(J)) GO TO 1000
      X=SLIM(J-1)
      SLIM(J-1)=SLIM(J)
      SLIM(J)=X
 1000 CONTINUE
      RETURN
      END
      SUBROUTINE READIN(A,T)
      DIMENSION A(2,1000),T(20)
      READ(1,9004) T
      DO 100  I=1,250
      I1=4*I-3
      I2=I1+3
      READ(1,8008) (A(2,J),A(1,J),J=I1,I2)
  100 CONTINUE
 8008 FORMAT(8E10.4)
 8004 FORMAT(20A4)
      END
      SUBROUTINE TRANSFER(T1,P1,T2,P2)
      DIMENSION T1(20),T2(20),P1(2,1000),P2(2,1000)
      DO 100 I=1,20
  100 T1(I)=T2(I)
      DO 200 I=1,2
      DO 200 J=1,1000
  200 P1(I,J)=P2(I,J)
      RETURN
      END
      FUNCTION FINTERP(TABLE,NTABLE,X)
C     DESIGNED FOR NTABLE.GT.10
C     INTERPOLATION FUNCTION FOR DATA STORED IN TABLE(2,NTABLE)
C     TABLE(1,N) IS INDEPENDENT VARIABLE
C     TABLE(2,N) IS DEPENDENT VARIABLE
C     X IS VALUE OF INDEPENDENT VARIABLE FOR EVALUATION OF FUNCTION
      DIMENSION TABLE(2,NTABLE)
      T=(1.0 + 1.0E-5)*TABLE(1,NTABLE)
      IF(X.LT.TABLE(1,1) .OR. X.GT.T)GO TO 2000
C     COARSE GRID SEARCH
      DO 500 I=10,NTABLE,10
      IF(TABLE(1,I)-X) 500,600,600
  500 CONTINUE
  600 ISTART=I-9
      DO 1000 I=ISTART,NTABLE
      IF(X.LE.TABLE(1,I))GO TO 1500
 1000 CONTINUE
 1500 IF(I.LT.3) I=3
      IF(I.GT.NTABLE-1) I=NTABLE-1
      X1=TABLE(1,I-2)
      X2=TABLE(1,I-1)
      X3=TABLE(1,I)
      X4=TABLE(1,I+1)
      Y1=TABLE(2,I-2)
      Y2=TABLE(2,I-1)
      Y3=TABLE(2,I)
      Y4=TABLE(2,I+1)
      Y=0
      CALL LAG(X1,X2,X3,X4,Y1,Y2,Y3,Y4,X,Y)
```

```
      FINTERP=Y
      RETURN
2000  PRINT 2001,X
2001  FORMAT(1H0,'FINTERP ERROR, X OUT OF RANGE, X=',1PE11.4)
      CALL EXIT
      END
      SUBROUTINE LAG(X1,X2,X3,X4,Y1,Y2,Y3,Y4,X,Y)
      IF(X1-X)40,200,40
  40  IF(X2-X)41,201,41
  41  IF(X3-X)42,202,42
  42  IF(X4-X)50,203,50
  50  A1=1.0/(X-X1)
  51  A2=1.0/(X-X2)
  55  A3=1.0/(X-X3)
  56  A4=1.0/(X-X4)
  60  AT=1.0/(A1*A2*A3*A4)
  70  B1=1.0/((X1-X2)*(X1-X3)*(X1-X4))
      B2=1.0/((X2-X1)*(X2-X3)*(X2-X4))
      B3=1.0/((X3-X1)*(X3-X2)*(X3-X4))
      B4=1.0/((X4-X1)*(X4-X2)*(X4-X3))
  80  Y=AT*(Y1*A1*B1+Y2*A2*B2+Y3*A3*B3+Y4*A4*B4 )
 100  RETURN
 200  Y=Y1
      RETURN
 201  Y=Y2
      RETURN
 202  Y=Y3
      RETURN
 203  Y=Y4
      RETURN
      END
```

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```
$ TYPE EXPORT2.DAT
E   LETFILES   SOLAR MINIMUM DIFFERENTIAL
5.1382E+041.6671E+002.3886E+041.6837E+001.1607E+041.7004E+008.4474E+031.7173E+00
7.2722E+031.7344E+006.2708E+031.7516E+005.3163E+031.7690E+001.4321E+041.7866E+00
9.0152E+031.8043E+002.7810E+031.8229E+002.7089E+031.8404E+002.6349E+031.8567E+00
2.5608E+031.8771E+002.4059E+031.8958E+002.4103E+031.9146E+002.2890E+031.9337E+00
2.1564E+031.9529E+002.0225E+031.9723E+001.8894E+031.9919E+001.8053E+032.0117E+00
1.7204E+032.0317E+001.6347E+032.0519E+001.5481E+032.0723E+001.4606E+032.0929E+00
1.3973E+032.1137E+001.3349E+032.1347E+001.2718E+032.1559E+001.2082E+032.1773E+00
1.1499E+032.1989E+001.0789E+032.2208E+001.0143E+032.2429E+009.7680E+022.2652E+00
9.3889E+022.2877E+009.0060E+022.3104E+008.6194E+022.3334E+008.2289E+022.3566E+00
7.8345E+022.3800E+007.4362E+022.4096E+007.0339E+022.4275E+006.6277E+022.4516E+00
6.2580E+022.4760E+006.0995E+022.5006E+005.9394E+022.5255E+005.7777E+022.5506E+00
5.6143E+022.5759E+005.4494E+022.6015E+005.2828E+022.6274E+005.1146E+022.6535E+00
4.9447E+022.6799E+004.7731E+022.7065E+004.5998E+022.7334E+004.4248E+022.7606E+00
4.2480E+022.7880E+004.0695E+022.8157E+003.8892E+022.8437E+003.7287E+022.8719E+00
3.5970E+022.9005E+003.4640E+022.9293E+003.3297E+022.9584E+003.1940E+022.9878E+00
3.0569E+023.0175E+002.9185E+023.0473E+002.7788E+023.0778E+002.6376E+023.1084E+00
2.4951E+023.1393E+002.3519E+023.1705E+002.2738E+023.2020E+002.1990E+023.2338E+00
2.1214E+023.2659E+002.0430E+023.2984E+001.9639E+023.3312E+001.8840E+023.3643E+00
1.8093E+023.3977E+001.7217E+023.4315E+001.6394E+023.4656E+001.5363E+023.5000E+00
1.4723E+023.5348E+001.3875E+023.5699E+001.3018E+023.6054E+001.2310E+023.6413E+00
1.1995E+023.6774E+001.1678E+023.7140E+001.1357E+023.7509E+001.1033E+023.7882E+00
1.0705E+023.8258E+001.0373E+023.8639E+001.0041E+023.9023E+009.7040E+013.9410E+00
9.3685E+013.9802E+009.0196E+014.0198E+008.6723E+014.0597E+008.3215E+014.1001E+00
7.9673E+014.1408E+007.6094E+014.1820E+007.2483E+014.2235E+006.8834E+014.2655E+00
6.5148E+014.3079E+006.1426E+014.3507E+005.8106E+014.3939E+005.6477E+014.4376E+00
5.4892E+014.4817E+005.3171E+014.5263E+005.1493E+014.5712E+004.9798E+014.6167E+00
4.8087E+014.6626E+004.6358E+014.7089E+004.4613E+014.7557E+004.2850E+014.8030E+00
4.1069E+014.8507E+003.9271E+014.8989E+003.7455E+014.9476E+003.5620E+014.9968E+00
3.3768E+015.0464E+003.1897E+015.0966E+003.0488E+015.1472E+002.9486E+015.1984E+00
2.8473E+015.2500E+002.7451E+015.3022E+002.6418E+015.3549E+002.5375E+015.4081E+00
2.4322E+015.4619E+002.3258E+015.5162E+002.2184E+015.5710E+002.1099E+015.6263E+00
2.0003E+015.6823E+001.8896E+015.7387E+001.7779E+015.7958E+001.6847E+015.8534E+00
1.6413E+015.9115E+001.5974E+015.9703E+001.5530E+016.0296E+001.5082E+016.0896E+00
1.4690E+016.1501E+001.4173E+016.2112E+001.3712E+016.2729E+001.3246E+016.3353E+00
1.2776E+016.3982E+001.2300E+016.4618E+001.1820E+016.5261E+001.1336E+016.5909E+00
1.0846E+016.6564E+001.0483E+026.7226E+001.8302E+026.7894E+001.3770E+026.8569E+00
1.1868E+026.9250E+001.0507E+026.9938E+009.4862E+017.0633E+009.8816E+027.1335E+00
6.2123E+017.2044E+005.8027E+017.2760E+005.7148E+017.3483E+006.6910E+017.4214E+00
5.5463E+017.4951E+005.4608E+017.5696E+005.3810E+017.6449E+005.2398E+017.7208E+00
5.0439E+017.7976E+004.8499E+017.8751E+004.6521E+017.9533E+004.4868E+018.0324E+00
4.3298E+018.1122E+004.1714E+018.1928E+004.0113E+018.2743E+003.8497E+018.3565E+00
3.7172E+018.4395E+003.5937E+018.5234E+003.4788E+018.6081E+003.3654E+018.6937E+00
3.2510E+018.7801E+003.1353E+018.8673E+003.0186E+018.9555E+002.9270E+019.0445E+00
2.8427E+019.1344E+002.7574E+019.2251E+002.6714E+019.3168E+002.3844E+019.4094E+00
2.4966E+019.5029E+002.4080E+019.5974E+002.3184E+019.6928E+002.2280E+019.7891E+00
2.1388E+019.8864E+002.0987E+019.9846E+002.0426E+011.0084E+012.0261E+011.0184E+01
1.9893E+011.0285E+011.9321E+011.0388E+011.9146E+011.0491E+011.8766E+011.0595E+01
1.8883E+011.0700E+011.7997E+011.0807E+011.7606E+011.0914E+011.7211E+011.1023E+01
1.6813E+011.1132E+011.6410E+011.1243E+011.6004E+011.1354E+011.5591E+011.1467E+01
1.5189E+011.1581E+011.4722E+011.1696E+011.4316E+011.1813E+011.3915E+011.1930E+01
1.3510E+011.2049E+011.3101E+011.2168E+011.2688E+011.2289E+011.2271E+011.2411E+01
1.1850E+011.2535E+011.1424E+011.2659E+011.1105E+011.2785E+011.0819E+011.2912E+01
1.0528E+011.3041E+011.0235E+011.3170E+019.9400E+001.3301E+019.6416E+001.3433E+01
9.3402E+001.3567E+019.0359E+001.3702E+018.7285E+001.3838E+018.4180E+001.3975E+01
8.1045E+001.4114E+017.7879E+001.4254E+017.4681E+001.4396E+017.1562E+001.4539E+01
7.0057E+001.4684E+016.8638E+001.4830E+016.7210E+001.4977E+016.3979E+001.5126E+01
6.7916E+001.5276E+016.5312E+001.5428E+016.3638E+001.5581E+016.1849E+001.5736E+01
```

```
6.0102E+001.3893E+016.0451E+001.6051E+015.6393E+001.6210E+015.4753E+001.6371E+01
5.3165E+001.6534E+015.1362E+001.6698E+014.9942E+001.6864E+014.8341E+001.7032E+01
4.6760E+001.7201E+014.5149E+001.7372E+014.3511E+001.7545E+014.2311E+001.7719E+01
4.1522E+001.7895E+014.0530E+001.8073E+013.9531E+001.8253E+013.8522E+001.8434E+01
3.7502E+001.8617E+013.6473E+001.8802E+013.5440E+001.8989E+013.4399E+001.9179E+01
3.3340E+001.9368E+013.2286E+001.9561E+013.1214E+001.9755E+013.0131E+001.9952E+01
2.9040E+002.0150E+012.7997E+002.0350E+012.7052E+002.0552E+012.6399E+002.0757E+01
2.5618E+002.0963E+012.4891E+002.1171E+012.4156E+002.1382E+012.3414E+002.1594E+01
2.2664E+002.1809E+012.1907E+002.2026E+012.1149E+002.2245E+012.0380E+002.2466E+01
1.9611E+002.2689E+001.8834E+002.2914E+001.8049E+002.3142E+001.7279E+002.3372E+01
1.6911E+002.3604E+011.6540E+002.3839E+011.6166E+002.4076E+011.3787E+002.4315E+01
1.5405E+002.4557E+011.5019E+002.4801E+011.4629E+002.5047E+011.4247E+002.5296E+01
1.4868E+002.5548E+011.3485E+002.5802E+011.3098E+002.6058E+011.2708E+002.6317E+01
1.2313E+002.6579E+011.5814E+002.6843E+011.2995E+002.7110E+011.2002E+002.7379E+01
1.1441E+002.7651E+011.1043E+002.7926E+011.0661E+002.8204E+011.0292E+002.8484E+01
1.0533E+002.8767E+019.4950E-012.9053E+019.1636E-012.9342E+018.8395E-012.9633E+01
9.5122E-012.9928E+018.1838E-013.0225E+017.8829E-013.0526E+017.6699E-013.0829E+01
7.4479E-013.1135E+017.2296E-013.1445E+016.9971E-013.1757E+016.7695E-013.2073E+01
6.5419E-013.2392E+016.3124E-013.2714E+016.0940E-013.3039E+016.0533E-013.3067E+01
5.6209E-013.9699E+015.3880E-013.4034E+015.1834E-013.4372E+015.0479E-013.4713E+01
4.9175E-013.5058E+014.7858E-013.5407E+014.6527E-013.5759E+014.5190E-013.6114E+01
4.3854E-013.6473E+014.2505E-013.6836E+014.1142E-013.7202E+013.9766E-013.7571E+01
3.8977E-013.7945E+013.6973E-013.8322E+013.5555E-013.8703E+013.4124E-013.9087E+01
3.2739E-013.9476E+013.1976E-013.9868E+013.1222E-014.0265E+013.0460E-014.0665E+01
2.9691E-014.1069E+012.8900E-014.1477E+012.0388E+004.1889E+019.9618E-014.2306E+01
4.4057E-014.2726E+019.9170E-014.3151E+016.6590E-014.3580E+014.4327E-014.4013E+01
3.2351E-014.4450E+011.8876E-014.4892E+017.3989E-014.5338E+016.6237E-014.5789E+01
2.5941E-014.6244E+014.4442E-014.6703E+013.9779E-014.7167E+013.4346E-014.7636E+01
2.2909E-014.8110E+012.9320E-014.8588E+011.7188E-014.9071E+011.1109E-014.9538E+01
2.0504E-015.0031E+019.9951E-015.0548E+019.3993E-015.1051E+018.8866E-015.1558E+01
1.8364E-015.2071E+017.8163E-015.2588E+017.7405E-015.3111E+016.9343E-015.3639E+01
1.6476E-015.4172E+016.0005E-015.4710E+015.5529E-015.5254E+015.0486E-015.5803E+01
1.4569E-015.6357E+014.1118E-015.6918E+013.9642E-015.7403E+013.2202E-015.8055E+01
1.2744E-015.8632E+012.3786E-015.9214E+012.0439E-015.9803E+019.9085E+006.0397E+01
7.9513E-016.0997E+012.2242E-016.1604E+014.3191E-016.2216E+018.8620E-016.2834E+01
9.5303E-016.3459E+013.2618E-016.4089E+011.4188E-016.4726E+013.3680E-016.5370E+01
2.2773E-016.6019E+012.2941E-016.6675E+011.9008E-016.7338E+011.1491E-016.8007E+01
2.1123E-016.8683E+012.0789E-016.9366E+012.0104E-017.0055E+019.9413E-017.0752E+01
1.8721E-017.1455E+018.0690E-017.2165E+017.5220E-017.2882E+016.6966E-017.3604E+01
1.6407E-017.4338E+015.8842E-017.5077E+015.5297E-017.5829E+014.4830E-017.6577E+01
1.4359E-017.7338E+013.9883E-017.8106E+013.9406E-017.8882E+012.9925E-017.9666E+01
1.2486E-018.0458E+012.1038E-018.1238E+011.1784E-018.2065E+011.0829E-018.2881E+01
1.9322E-018.3705E+016.8988E-018.4537E+015.8811E-018.5977E+014.4816E-018.6225E+01
1.3985E-018.7082E+017.9598E-018.7948E+011.1969E-018.8822E+011.1537E-018.9705E+01
1.1305E-019.0596E+011.1080E-019.1497E+011.0863E-019.2406E+011.0643E-019.3324E+01
1.0424E-019.4252E+011.0151E-019.5189E+018.8594E-029.6135E+015.5647E-029.7090E+01
9.2801E-029.8055E+010.3017E-029.9030E+018.0056E-021.0001E+025.5772E-021.0101E+02
8.3466E-021.0201E+021.1136E-021.0303E+028.9905E-021.0405E+026.6661E-021.0508E+02
7.4399E-021.0613E+022.2120E-021.0718E+022.2505E-011.0825E+029.9214E-011.0932E+02
2.8968E-011.1041E+021.6937E-011.1151E+029.9521E-011.1262E+027.8883E-011.1374E+02
3.2711E-011.1487E+019.3223E-011.1601E+012.6834E-011.1716E+012.2407E-011.1832E+02
1.2178E-011.1950E+021.1946E-011.2069E+021.1718E-011.2189E+021.1504E-011.2310E+02
1.1148E-011.2432E+021.0742E-011.2556E+021.0332E-011.2681E+029.9182E-011.2807E+02
9.3955E-021.2934E+022.2727E-021.3042E+029.9773E-011.3192E+026.9700E-011.3329E+02
8.4140E-021.3456E+027.7219E-021.3590E+023.0008E-021.3725E+027.7474E-021.3861E+02
7.4458E-021.3999E+021.1852E-021.4138E+029.9268E-021.4278E+026.6743E-021.4420E+02
6.7101E-021.4564E+022.2631E-021.4709E+020.0832E-021.4855E+029.9055E-021.5002E+02
5.7261E-021.5151E+025.5449E-021.5302E+023.9621E-021.5454E+021.1780E-021.5608E+02
4.9970E-021.5763E+024.8928E-021.5919E+024.7336E-021.6077E+024.6351E-021.6237E+02
4.5367E-021.6399E+024.4373E-021.6562E+024.3370E-021.6726E+020.9333E-011.6892E+02
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6.8018E-021.7060E+025.7914E-021 7230E+025.4463E-021.7401E+025.1525E-021 7574E+02
4.8968E-021.7749E+026.2560E-021 7925E+024.2760E-021.8103E+024 1331E-021.8283E+02
4.0289E-021.8465E+023.9928E-021.8648E+023.8961E-021.8834E+023 7387E-021.9021E+02
3.6414E-021.9210E+026.5319E-021.9401E+023.4144E-021.9594E+023.2958E-021.9788E+02
3.1759E-021.9985E+023.0648E-022 0184E+024.2114E-022.0384E+023.2903E-022.0587E+02
3.0940E-022.0792E+022.9504E-022.0998E+022.8377E-022.1207E+022.7338E-022.1418E+02
2.6448E-022.1631E+022.8146E-022.1846E+024.4914E-022.2063E+023.3539E-022.2282E+02
8.2774E-022.2509E+022.2053E-022.2727E+021.1333E-022.2953E+022.0608E-022.3181E+02
1.9954E-022.3411E+021.9432E-022.3644E+021.8906E-022.3879E+021.8374E-022.4116E+02
6.8192E-022.4856E+023.8612E-022.4598E+022.2631E-022.4843E+023.0265E-022.5090E+02
2.8104E-022.5339E+026.6380E-022.5591E+029.9991E-022.5843E+022.1614E-022.6102E+02
2.0796E-022.6361E+022.0293E-022.6623E+029.9788E-022.6888E+021.9287E-022.7155E+02
1.8800E-022.7425E+021.8342E-022.7698E+021.7754E-022.7973E+021.7149E-022.8251E+02
2.5606E-022.8532E+021.9498E-022.8815E+021.8118E-022.9102E+021.7296E-022.9391E+02
1.6572E-022.9683E+021.5895E-022.9978E+021.7487E-023.0276E+021.4418E-023.0577E+02
1.3980E-023.0881E+021.3514E-023.1188E+021.3098E-023.1498E+021.2477E-023.1811E+02
1.2272E-023.2127E+021.1865E-023.2446E+021.1494E-023.2768E+021.1145E-023.3094E+02
3.4405E-023.3423E+022.2093E-023.3755E+021.8767E-023.4091E+021.7323E-023.4430E+02
1.6133E-023.4772E+021.5143E-023.5117E+0...2.2154E-023.5466E+021.2289E-023.5819E+02
1.1810E-023.6175E+021.1519E-023.6534E+021.2455E-023.6897E+021.0969E-023.7264E+02
1.0725E-023.7634E+021.0511E-023.8009E+021.1351E-023.8386E+021.0500E-023.8768E+02
1.0059E-023.9153E+029.7050E-033.9542E+029.3987E-033.9935E+029.0995E-034.0332E+02
9.1962E-034.0733E+028.4487E-034.1138E+028.1632E-034.1547E+027.9105E-034.1960E+02
7.6717E-034.2977E+027.4417E-034.2798E+027.2093E-034.3223E+026.0810E-024.3653E+02
8.6204E-034.4086E+026.9185E-034.4525E+027.5451E-034.4967E+027.2145E-034.5414E+02
6.9187E-034.5865E+026.9851E-034.6321E+026.2142E-034.6782E+026.0018E-034.7247E+02
5.8187E-034.7716E+025.6954E-034.8190E+024.5529E-034.8669E+026.6150E-034.9153E+02
6.1828E-034.9642E+025.7089E-035.0135E+025.4439E-035.0633E+025.2111E-035.1136E+02
5.0021E-035.1645E+024.2744E-035.2158E+025.5699E-035.2676E+024.4249E-035.3200E+02
4.2992E-035.3729E+024.1763E-035.4263E+025.0164E-035.4802E+026.4706E-035.5346E+02
5.1724E-035.5897E+024.7138E-035.6452E+024.4460E-035.7013E+024.2204E-035.7580E+02
4.0214E-035.8152E+024.6161E-035.8730E+023.5759E-035.9314E+024.4459E-035.9903E+02
3.8340E-036.0499E+027.0040E-036.1100E+024.6050E-036.1707E+028.8550E-036.2320E+02
3.5498E-036.2940E+023.3575E-036.3565E+029.2040E-036.4197E+020.0684E-036.4835E+02
3.4218E-036.5479E+022.7623E-036.6130E+026.6695E-036.6787E+025.3864E-036.7451E+02
6.9714E-036.8122E+024.3987E-036.8799E+027.7297E-036.9482E+024.4228E-037.0173E+02
3.1627E-037.0870E+022.9475E-037.1575E+021.1101E-037.2286E+024.4150E-037.3004E+02
2.3044E-037.3730E+022.2914E-037.4463E+020.0839E-037.5203E+025.5133E-037.5950E+02
2.3862E-037.6705E+022.2303E-037.7467E+021.1291E-037.8237E+022.0336E-037.9015E+02
2.1395E-037.9800E+021.8229E-038.0593E+021.7306E-038.1394E+021.6886E-038.2203E+02
3.9486E-038.3020E+022.6719E-038.3843E+022.2924E-038.4679E+021.2865E-038.5520E+02
1.9942E-038.6370E+021.8846E-038.7229E+023.3276E-038.8095E+026.6021E-038.8971E+02
1.3281E-038.9855E+021.5311E-039.0748E+029.9371E-039.1650E+021.7462E-039.2561E+02
1.6300E-039.3481E+021.5721E-039.4410E+024.4967E-039.5348E+021.6712E-039.6296E+02
1.3109E-039.7258E+021.6306E-039.8220E+022.5159E-039.9196E+029.9594E-031.0018E+03
1.7989E-031.0118E+031.6069E-031.0218E+031.5154E-031.0320E+031.4263E-031.0422E+03
1.8071E-031.0526E+031.2011E-031.0631E+032.2785E-031.0736E+036.6896E-031.0843E+03
1.4940E-031.0951E+031.3944E-031.1060E+031.3189E-031.1169E+032.4887E-031.1280E+03
1.4809E-031.1393E+031.1039E-031.1506E+038.8202E-031.1620E+036.6397E-031.1736E+03
4.8276E-031.1852E+037.7321E-031.1970E+033.3443E-031.2089E+030.0190E-031.2209E+03
6.1512E-031.2331E+032.0398E-031.2453E+031.8643E-031.2577E+037.7969E-031.2702E+03
1.7385E-031.2828E+031.6825E-031.2956E+031.6272E-031.3084E+031.5703E-031.3213E+03
2.3871E-031.3346E+031.7720E-031.3478E+031.5259E-031.3612E+031.4018E-031.3748E+03
1.3249E-031.3884E+031.2551E-031.4022E+031.1882E-031.4162E+032.6544E-031.4302E+03
1.0433E-031.4444E+031.0010E-031.4588E+039.6204E-041.4733E+032.3345E-041.4879E+03
8.8549E-041.5027E+034.7379E-041.5177E+031.0887E-041.5328E+037.7298E-041.5480E+03
7.4358E-041.5634E+031.7513E-041.5789E+038.8754E-041.5946E+036.6083E-041.6104E+03
6.3417E-041.6265E+030.0729E-041.6426E+038.8017E-041.6589E+035.5384E-041.6754E+03
5.2835E-041.6921E+031.1067E-041.7089E+034.9582E-041.7259E+034.8092E-041.7430E+03
4.6389E-041.7604E+034.5135E-041.7779E+033.3734E-041.7953E+042.2353E-041.8134E+03
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4.0977E-041 .0314E+039 .9605E-041 .8496E+039 .8281E-041 .8680E+039 .6949E-041 .8865E+03
3.5636E-041 .9053E+039 .4359E-041 .9242E+033 .3086E-041 .9434E+039 .1873E-041 .9627E+039
3.0913E-041 .9822E+032 .9768E-042 .0019E+032 .8760E-042 .0218E+032 .7747E-042 .0419E+039
2.6732E-042 .0622E+032 .5713E-042 .0827E+032 .4685E-042 .1033E+032 .3712E-042 .1243E+039
2.2722E-042 .1454E+032 .1836E-042 .1667E+032 .1159E-042 .1882E+032 .0486E-042 .2100E+039
1.9908E-042 .2319E+031 .9147E-042 .2541E+031 .8497E-042 .2763E+031 .7863E-042 .2991E+039
1.7249E-042 .3220E+031 .6444E-042 .3451E+031 .6047E-042 .3684E+031 .5446E-042 .3919E+039
1.4839E-042 .4157E+031 .4298E-042 .4397E+031 .3637E-042 .4639E+031 .3162E-042 .4884E+039
1.2794E-042 .5132E+031 .2438E-042 .5381E+031 .2100E-042 .5634E+031 .1762E-042 .5888E+039
1.1424E-042 .6146E+031 .1083E-042 .6406E+031 .0738E-042 .6668E+031 .0376E-042 .6933E+039
1.0029E-042 .7201E+039 .6833E-052 .7471E+039 .3654E-052 .7744E+039 .0497E-052 .8020E+039
8.7441E-052 .0298E+038 .4383E-052 .8580E+038 .1422E-052 .8864E+037 .8300E-052 .9150E+039
7.3583E-052 .9440E+037 .2773E-052 .9733E+037 .0718E-053 .0028E+036 .8686E-053 .0327E+039
6.6673E-053 .0628E+036 .4739E-053 .0933E+036 .2809E-053 .1240E+036 .0949E-053 .1550E+039
5.9100E-053 .1854E+035 .7282E-053 .2181E+035 .5466E-053 .2501E+035 .3632E-053 .2824E+039
5.1812E-053 .3150E+035 .0016E-053 .3479E+034 .8301E-053 .3812E+034 .6605E-053 .4148E+039
4.4908E-053 .4487E+034 .3514E-059 .4830E+034 .2177E-053 .5176E+034 .0837E-053 .5526E+039
3.9502E-053 .5879E+039 .8229E-053 .6236E+039 .7091E-053 .6596E+039 .5880E-053 .6939E+039
3.4735E-053 .7327E+039 .3591E-053 .7698E+039 .2439E-053 .8072E+039 .1276E-053 .8451E+039
2.9744E-053 .8833E+032 .8639E-053 .9219E+032 .7895E-053 .9609E+032 .7156E-054 .0002E+039
2.6432E-054 .0400E+032 .5719E-054 .0801E+032 .5015E-054 .1207E+032 .4317E-054 .1616E+039
2.3614E-054 .2030E+032 .2920E-054 .2448E+032 .2246E-054 .2870E+032 .1596E-054 .3296E+039
2.0946E-054 .3726E+032 .0295E-054 .4161E+031 .9648E-054 .4600E+031 .9013E-054 .5049E+039
1.8874E-054 .5490E+031 .7787E-054 .5943E+031 .7275E-054 .6399E+031 .6673E-054 .6860E+039
1.6173E-054 .7326E+031 .5669E-054 .7796E+031 .5189E-054 .8271E+031 .4715E-054 .8751E+039
1.4244E-054 .9296E+031 .3769E-054 .9725E+031 .3300E-055 .0219E+031 .2897E-055 .0718E+039
1.2324E-055 .1222E+031 .2156E-055 .1722E+031 .1801E-055 .2246E+031 .1447E-055 .2763E+039
1.1100E-055 .3289E+031 .0761E-055 .3819E+031 .0422E-053 .4354E+031 .0093E-055 .4894E+039
9.7689E-065 .5440E+039 .4403E-065 .5991E+039 .1568E-065 .6547E+038 .8954E-065 .7109E+039
8.6480E-065 .7677E+038 .3999E-065 .8250E+038 .1635E-065 .8829E+037 .9936E-065 .9414E+039
7.7036E-066 .0004E+037 .4721E-066 .0600E+036 .9639E-066 .1203E+036 .7425E-066 .1811E+039
6.5204E-066 .2425E+036 .2988E-066 .3046E+036 .0883E-066 .3672E+035 .9184E-066 .4305E+039
5.7581E-066 .4944E+035 .5994E-066 .5590E+035 .4414E-066 .6242E+035 .2821E-066 .6900E+039
5.1236E-066 .7565E+034 .9662E-066 .8296E+034 .8133E-066 .8914E+034 .6643E-066 .9599E+039
4.5197E-067 .0291E+034 .3769E-067 .0990E+034 .2390E-067 .1695E+034 .0881E-067 .2408E+039
3.9460E-067 .3127E+033 .8038E-067 .3854E+033 .6954E-067 .4588E+038 .6054E-067 .5330E+039
3.5174E-067 .6078E+033 .4309E-067 .6834E+033 .3415E-067 .7598E+033 .2563E-067 .8369E+039
3.1707E-067 .9140E+033 .0869E-067 .9935E+038 .0016E-068 .0729E+032 .9163E-068 .1532E+039
2.8821E-068 .2342E+032 .7497E-068 .3160E+032 .6693E-068 .3987E+032 .5911E-068 .4821E+039
2.5138E-068 .5664E+032 .4380E-068 .6516E+032 .3653E-068 .7376E+032 .2923E-068 .0244E+039
2.2212E-068 .9121E+032 .1561E-069 .0007E+032 .0980E-069 .0901E+032 .0418E-069 .1805E+039
1.9863E-069 .2717E+031 .9305E-069 .3639E+031 .8765E-069 .4569E+031 .7967E-069 .5509E+039
1.7440E-069 .6436E+031 .6909E-069 .7417E+031 .6376E-069 .8385E+031 .5850E-069 .9363E+039
1.5349E-061 .0095E+041 .4880E-061 .0135E+041 .4514E-061 .0236E+041 .4153E-061 .0337E+04
1.3820E-061 .0440E+041 .3490E-061 .0544E+041 .3164E-061 .0649E+041 .2838E-061 .0754E+04
1.2548E-061 .0861E+041 .2344E-061 .0969E+041 .2142E-061 .1078E+041 .1939E-061 .1188E+04
1.0205E-061 .1300E+049 .8876E-071 .1412E+049 .5235E-071 .1325E+049 .2077E-071 .1640E+04
8.9400E-071 .1755E+048 .7243E-071 .1872E+048 .5212E-071 .1990E+048 .3172E-071 .2109E+04
8.1119E-071 .2230E+047 .9046E-071 .2351E+047 .7078E-071 .2474E+047 .5208E-071 .2598E+04
7.3822E-071 .2729E+047 .1428E-071 .2850E+046 .8874E-071 .2977E+046 .7038E-071 .3106E+04
6.5205E-071 .3237E+046 .3366E-071 .3368E+046 .1531E-071 .3501E+045 .9787E-071 .3635E+04
5.5583E-071 .3771E+045 .3939E-071 .3908E+045 .2639E-071 .4046E+045 .1445E-071 .4186E+04
5.0380E-071 .4327E+044 .9911E-071 .4469E+044 .8246E-071 .4613E+044 .4726E-071 .4758E+04
4.3579E-071 .4905E+044 .2444E-071 .5053E+044 .1313E-071 .5202E+044 .0194E-071 .5353E+04
3.9080E-071 .5506E+043 .7980E-071 .5660E+043 .6911E-071 .5816E+043 .5969E-071 .5973E+04
3.4746E-071 .6132E+043 .3949E-071 .6292E+043 .3163E-071 .6454E+043 .2401E-071 .6617E+04
3.0369E-071 .6783E+042 .9517E-071 .6949E+042 .8683E-071 .7118E+042 .7871E-071 .7288E+04
2.7171E-071 .7460E+042 .6583E-071 .7633E+042 .6012E-071 .7809E+042 .5539E-071 .7986E+04
2.5138E-071 .8164E+042 .4766E-071 .8345E+042 .4400E-071 .8527E+042 .2029E-071 .8711E+04
2.1529E-071 .8897E+042 .1115E-071 .9083E+042 .0761E-071 .9275E+042 .0456E-071 .9466E+04
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2.0622E-071.9660E+042.1293E-071.9835F+042.2023E-072.0053E+042.1894E-072.0252E+04
1.6134E-072.0453E+041.5880E-072.0656E+041.4473E-072.0862E+041.4182F-072.1069F+04
1.3942E-072.1278E+041.3917E-072.1490E+041.4116E-072.1704E+041.4397E-072.1919E+04
1.4286E-072.2137E+041.1708E-072.2337E+041.1601E-072.2579F+041.1596E-072.2804E+04
1.0340E-072.3030E+041.0270E-072.3259E+041.0894E-072.3490E+041.1617E-072.3724F+04
1.2069E-072.3960E+047.5901E-082.4198E+047.4536E-082.4438E+047.3892F-082.4601E+04
7.4177E-082.4926E+047.4905E-082.5174E+047.3611E-082.5424E+047.8960E-082.5677F+04
8.3943E-082.5932E+048.4180E-082.6190E+045.5325F-082.6450E+047.7438F-082.6713F+04
6.0146E-082.6979E+042.2889E-082.7247E+042.0859E-082.7518E+041.0502E-072.7791E+04
1.2713E-072.8067E+042.2979F-072.8346E+042.4286E-092.8628E+042.4193E-092.8912E+04
2.4247E-092.9200E+042.4413E-092.9490E+042.5700E-092.9783E+042.7000E-093.0079E+04
2.7640E-093.0378E+042.0645E-093.0680E+042.1318E-093.0985E+042.2607E-093.1293E+04
2.3706E-093.1604E+042.0910E-093.1918E+044.0753E-093.2235E+044.9035E-093.2536E+04
C   LETFILES SOLAR MAXIMUM DIFFERENTIAL
2.8898E+041.6671E+001.9809E+041.6897E+006.7355E+031.7004E+004.7411E+031.7173E+00
4.0045E+031.7344E+003.3680E+031.7516E+002.8972E+031.7690E+001.0457E+041.7846E+00
1.0169E+031.8049E+009.0039E+021.8223E+008.5735E+021.8404E+008.1360E+021.8587E+00
7.6937E+021.8771E+007.2502E+021.8958E+006.8003E+021.9146E+006.3199E+021.9337E+00
5.8290E+021.9529E+005.3381E+021.9723E+004.8412E+021.9919E+005.3564E+022.0117E+00
4.2688E+022.0817E+003.9783E+022.0319E+003.6850E+022.0723E+003.3887E+022.0929E+00
3.2082E+022.1137E+003.0210E+022.1347E+002.8380E+022.1559E+002.6532E+022.1773E+00
2.4666E+022.1989E+002.2781E+022.2208E+022.0912E+022.2429E+011.9982E+022.2652E+00
1.9049E+022.2877E+011.8094E+022.3104E+011.7136E+022.3394E+011.6168E+022.3566E+00
1.5191E+022.3800E+011.4204E+022.4036E+011.3207E+022.4273E+011.2200E+022.4514E+00
1.1292E+022.4760E+011.0946E+022.5006E+011.0396E+022.5235E+011.0243E+022.5506E+00
9.8864E+012.5739E+099.3262E+012.6013E+099.1625E+012.6274E+087.9931E+012.6335E+00
8.4241E+012.6799E+088.0494E+012.7063E+077.6709E+012.7334E+072.8887E+012.7606E+00
6.9027E+012.7860E+065.3129E+012.8157E+061.1192E+012.8437E+057.9271E+012.8719E+00
5.3426E+012.9003E+053.3803E+012.9299E+050.0956E+012.9584E+048.5585E+012.9878E+00
4.6192E+013.0175E+043.3774E+013.0475E+041.1332E+013.0778E+038.8867E+013.1084E+00
3.6976E+013.1393E+033.3877E+013.1705E+032.2695E+013.2020E+031.1501E+013.2338E+00
8.0295E+013.2659E+029.9078E+013.2984E+027.8488E+013.3912E+026.6606E+013.3643E+00
2.5352E+013.3977E+022.4085E+013.4315E+022.2805E+013.4656E+021.1513E+013.5000E+00
2.0208E+013.5848E+011.8890E+013.5699E+011.7559E+013.6054E+011.6472E+013.6413E+00
1.6081E+013.6774E+011.5585E+013.7140E+011.5135E+013.7509E+011.4680E+013.7882E+00
1.4221E+013.8258E+011.3758E+013.8689E+011.3289E+013.9023E+011.2816E+013.9410E+00
1.2399E+013.9802E+011.1856E+014.0198E+011.1369E+014.0597E+011.0877E+014.1001E+00
1.0390E+014.1408E+098.8781E+004.1820E+099.3712E+044.2295E+088.8593E+044.2655E+00
8.3423E+044.3079E+077.8202E+044.3507E+077.3584E+044.3939E+077.1498E+044.4373E+00
6.9891E+044.4817E+066.7262E+044.5263E+066.5113E+044.5712E+066.2942E+044.6167E+00
6.0750E+044.6626E+055.8536E+044.7089E+056.2999E+044.7557E+054.0041E+044.8030E+00
5.1760E+044.8507E+049.4537E+044.8989E+047.1319E+044.9476E+044.4781E+044.9968E+00
4.2408E+045.0464E+044.0012E+055.0966E+033.8232E+055.1472E+036.6996E+035.1984E+00
8.3747E+035.2500E+034.4487E+035.3022E+033.3213E+035.3549E+033.1927E+035.4081E+00
3.0628E+035.4619E+022.9317E+035.5162E+022.7992E+035.5710E+022.6654E+035.6263E+00
2.5308E+035.6823E+023.9938E+035.7387E+022.3560E+035.7958E+022.1414E+035.8534E+00
2.0890E+005.9115E+022.0361E+055.9703E+011.9826E+066.0296E+011.9286E+066.0896E+00
1.8741E+066.1301E+011.8190E+066.2112E+011.7684E+066.2729E+011.7072E+066.3353E+00
1.6504E+066.3982E+011.5931E+066.4618E+011.5353E+066.5261E+011.4768E+066.5909E+00
1.4178E+066.6564E+022.7650E+266.7226E+011.1933E+266.7894E+005.5673E+016.8569E+00
7.1391E+016.9250E+061.1004E+016.9938E+053.3920E+177.0633E+014.4667E+027.1335E+00
2.6626E+017.2044E+024.4099F+017.2760E+023.3297E+017.3483E+022.2577E+017.4214E+00
2.1850E+017.4951E+022.1116E+017.5696E+022.0381E+017.6449E+011.9478E+017.7208E+00
1.8497E+017.7976E+011.7387E+017.8751E+011.6325E+017.9533E+011.5510E+018.0324E+00
1.4761E+018.1122E+011.4005E+018.1926E+011.3241E+018.2743E+011.2470E+018.3565E+00
1.1893E+018.4395E+011.1391E+018.5234E+011.0890E+018.6081E+011.0391E+018.6937E+00
9.8865E+008.7801E+009.3771E+008.8673E+008.8625E+008.9535E+008.3047E+009.0445E+00
8.1926E+099.1944E+077.8774E+099.2251E+075.5390E+099.3168E+072.2375E+099.4094E+00
6.9128E+099.3029E+065.8849E+099.3974E+062.2537E+099.6928E+059.9192E+099.7891E+00
5.5841E+099.8864E+054.4386E+099.9846E+053.3101E+011.0084E+011.1803E+011.0184E+01

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5.0491E+001.0285E+014.9167E+001.0388E+014.7830E+001.0491E+014.6480E+001.0595E+01
4.5116E+001.0700E+014.3738E+001.0807E+014.2347E+001.0914E+014.0942E+001.1028E+01
3.9523E+001.1132E+013.8090E+001.1243E+013.6642E+001.1354E+013.5230E+001.1467E+01
3.4085E+001.1581E+013.2928E+001.1696E+013.1807E+001.1813E+013.0688E+001.1930E+01
2.9558E+001.2049E+012.8416E+001.2168E+012.7263E+001.2289E+012.6099E+001.2411E+01
2.4929E+001.2535E+012.3735E+001.2659E+012.2930E+001.2783E+012.2245E+001.2912E+01
2.1554E+001.3041E+012.0856E+001.3170E+012.0151E+001.3301E+011.9439E+001.3433E+01
1.8720E+001.3567E+011.7993E+001.3702E+011.7260E+001.3838E+011.6519E+001.3975E+01
1.5771E+001.4114E+011.5013E+001.4254E+011.4252E+001.4396E+011.3511E+001.4539E+01
1.3200E+001.4684E+011.2898E+001.4830E+011.2593E+001.4977E+011.8011E+001.5126E+01
1.4481E+001.5276E+011.3417E+001.5428E+011.2803E+001.5581E+011.2257E+001.5736E+01
1.1752E+001.5893E+011.1122E+001.6051E+011.0573E+001.6210E+011.0186E+001.6371E+01
9.8945E-011.6534E+019.4802E-011.6699E+019.1223E-011.6864E+018.7659E-011.7032E+01
8.4113E-011.7201E+018.0496E-011.7372E+017.6816E-011.7545E+017.4806E-011.7719E+01
7.2832E-011.7895E+017.0892E-011.8073E+016.8948E-011.8253E+016.6985E-011.8434E+01
6.5002E-011.8617E+016.2999E-011.8802E+016.1019E-011.8989E+015.9035E-011.9178E+01
5.7038E-011.9368E+015.5009E-011.9561E+015.2966E-011.9755E+015.0903E-011.9952E+01
4.8824E-012.0150E+014.6853E-012.0350E+014.5113E-012.0552E+014.3897E-012.0757E+01
4.2670E-012.0963E+014.1490E-012.1171E+014.0178E-012.1382E+013.8913E-012.1594E+01
3.7636E-012.1809E+013.6347E-012.2026E+013.5044E-012.2245E+013.3768E-012.2466E+01
3.2492E-012.2689E+013.1184E-012.2914E+012.9873E-012.3142E+012.8588E-012.3372E+01
2.7996E-012.3604E+012.7399E-012.3889E+012.6796E-012.4076E+012.6187E-012.4315E+01
2.5371E-012.4557E+012.4950E-012.4801E+012.4322E-012.5047E+012.3704E-012.5296E+01
2.3089E-012.5548E+012.2468E-012.5802E+012.1848E-012.6058E+012.1221E-012.6317E+01
2.0588E-012.6579E+011.7275E-012.6843E+011.9372E-012.7110E+011.4660E-012.7379E+01
2.2646E-012.7651E+012.1459E-012.7926E+012.0403E-012.8204E+011.9491E-012.8484E+01
2.4010E-012.8767E+011.7150E-012.9053E+011.6571E-012.9342E+011.6046E-012.9638E+01
1.5515E-012.9928E+011.4973E-013.0225E+011.4464E-013.0526E+011.4092E-013.0829E+01
1.3696E-013.1135E+011.3295E-013.1445E+011.2891E-013.1757E+011.2490E-013.2073E+01
1.2101E-013.2392E+011.1709E-013.2714E+011.1321E-013.3039E+011.0931E-013.3367E+01
1.0539E-013.3699E+011.0157E-013.4034E+019.8147E-023.4372E+019.5835E-023.4713E+01
9.3484E-023.5058E+019.1315E-023.5407E+018.9329E-023.5759E+018.7147E-023.6114E+01
8.5099E-023.6473E+018.2911E-023.6833E+018.0761E-023.7202E+017.8590E-023.7571E+01
7.6297E-023.7945E+027.4182E-023.8322E+017.1946E-023.8703E+016.9687E-023.9087E+01
6.7491E-023.9476E+016.6204E-023.9868E+016.4978E-024.0265E+016.3737E-024.0665E+01
6.2484E-024.1069E+016.1076E-024.1477E+015.8194E-024.1889E+025.8264E-024.2306E+01
1.7518E-014.2726E+014.4918E-014.3131E+014.2820E-014.3580E+014.1538E-014.4013E+01
1.0522E-014.4450E+019.9729E-024.4892E+015.5464E-024.5398E+015.1822E-024.5789E+01
6.9620E-024.6244E+016.7413E-024.6703E+015.5322E-024.7167E+015.3939E-024.7636E+01
6.2940E-024.8110E+016.0824E-024.8588E+015.8267E-024.9071E+015.6189E-024.9558E+01
5.4166E-025.0051E+015.2485E-025.0548E+015.0797E-025.1051E+014.9223E-025.1558E+01
4.7749E-025.2071E+014.6298E-025.2588E+024.5109E-025.3111E+014.3913E-025.3639E+01
4.2706E-025.4172E+014.1486E-025.4710E+014.0255E-025.5254E+013.9011E-025.5803E+01
3.7795E-025.6357E+013.6766E-025.6918E+013.5728E-025.7489E+013.4680E-025.8055E+01
3.3636E-025.8632E+013.2683E-025.9214E+013.1733E-025.9803E+012.2861E+006.0397E+01
5.0139E-016.0997E+013.0521E-016.1604E+012.3867E-016.2216E+013.0488E-016.2834E+01
1.8020E-016.3459E+016.6166E-016.4089E+014.2274E-016.4726E+011.1111E-026.5370E+01
8.5884E-026.6019E+018.3237E-026.6675E+018.0614E-026.7338E+018.0007E-026.8007E+01
7.5442E-026.8689E+017.3032E-026.9366E+017.9668E-027.0055E+016.2276E-027.0752E+01
6.2856E-027.1455E+015.9746E-027.2165E+017.3967E-027.2882E+014.9965E-027.3606E+01
5.2540E-027.4398E+015.0090E-027.5077E+014.7786E-027.5829E+014.6030E-027.6577E+01
4.4258E-027.7398E+014.2470E-027.8106E+014.0664E-027.8882E+013.8851E-027.9666E+01
3.7116E-028.0458E+013.5585E-028.1258E+013.4452E-028.2063E+011.6844E-018.2881E+01
8.7174E-028.3705E+017.0188E-028.4537E+016.3243E-028.5377E+016.6862E-028.6225E+01
5.1814E-028.7082E+019.4297E-028.7948E+018.8246E-028.8822E+016.4193E-028.9703E+01
3.3182E-029.0596E+013.4188E-029.1497E+013.3210E-029.2406E+013.2223E-029.3324E+01
3.1229E-029.4252E+013.0095E-029.5189E+012.8909E-029.6135E+012.7710E-029.7090E+01
2.6558E-029.8055E+012.5617E-029.9030E+012.4707E-021.0001E+022.3788E-021.0101E+02
2.2859E-021.0201E+022.1922E-021.0303E+022.1136E-021.0405E+022.0422E-021.0508E+02
1.9681E-021.0613E+021.8934E-021.0718E+024.0641E-011.0825E+021.7638E-011.0932E+02
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1.3048E-011.1041E+021.1380E-011.1151E+029.8396E-021.1262E+020.5779E-021.1374E+02
2.2123E-011.1487E+024.9683E-021.1601E+024.6204E-021.1716E+024.4785E-021.1892E+02
4.3352E-021.1950E+024.1905E-021.2069E+024.0453E-021.2189E+023.9003E-021.2310E+02
3.7325E-021.2432E+023.5427E-021.2556E+023.3510E-021.2681E+023.1574E-021.2807E+02
3.0203E-021.2934E+022.8839E-021.3062E+022.7541E-021.3192E+022.6279E-021.3323E+02
2.5003E-021.3456E+022.5004E-021.3590E+022.6188E-021.3725E+022.2936E-021.3861E+02
2.1480E-021.3999E+022.0344E-021.4138E+021.9234E-021.4278E+021.8184E-021.4420E+02
1.9504E-021.4564E+021.6513E-021.4708E+021.5889E-021.4855E+021.5282E-021.5002E+02
1.4669E-021.5151E+021.4050E-021.5302E+021.9424E-021.5454E+021.2795E-021.5608E+02
1.2178E-021.5763E+021.1616E-021.5919E+021.1316E-021.6077E+021.1015E-021.6297E+02
1.0719E-021.6399E+021.0419E-021.6562E+021.0116E-021.6726E+025.2524E-021.6892E+02
2.5614E-021.7060E+022.0738E-021.7230E+021.8608E-021.7401E+021.6832E-021.7574E+02
1.5349E-021.7749E+022.8177E-021.7925E+021.1203E-021.8103E+021.0585E-021.8283E+02
1.0221E-021.8465E+029.9031E-031.8648E+029.5826E-031.8834E+029.2593E-031.9021E+02
8.9349E-031.9210E+028.5766E-031.9401E+028.1973E-031.9594E+027.8142E-031.9788E+02
7.4273E-031.9985E+027.0912E-032.0184E+025.5582E-022.0384E+024.4089E-032.0587E+02
8.3460E-032.0792E+027.6885E-032.0998E+027.2170E-032.1207E+026.7888E-032.1418E+02
6.4744E-032.1631E+026.4556E-032.1846E+025.5121E-032.2063E+025.2792E-032.2282E+02
5.0543E-032.2503E+024.8562E-032.2727E+024.6604E-032.2953E+024.4630E-032.3181E+02
4.2848E-032.3411E+024.1425E-032.3644E+023.9987E-032.3879E+023.8535E-032.4116E+02
3.8917E-022.4356E+023.8001E-022.4598E+023.7688E-022.4843E+023.2209E-022.5090E+02
1.0756E-022.5399E+026.6346E-032.5591E+022.1812E-022.5845E+021.7742E-032.6102E+02
5.7975E-032.6361E+025.6056E-032.6623E+024.4119E-032.6886E+022.2191E-032.7155E+02
5.0814E-032.7425E+024.8488E-032.7698E+024.6310E-032.7973E+024.4083E-032.8231E+02
1.0511E-022.8532E+022.2950E-032.8815E+024.4930E-032.9102E+025.0678E-032.9391E+02
4.7091E-032.9683E+023.3861E-032.9978E+026.0768E-033.0276E+026.6101E-033.0377E+02
3.4416E-033.0881E+023.3064E-033.1188E+023.1714E-033.1498E+023.0951E-033.1811E+02
2.9045E-033.2127E+022.7732E-033.2446E+022.6676E-033.2768E+022.5661E-033.3094E+02
1.8905E-023.3423E+021.0262E-023.3755E+027.9152E-033.4091E+026.9591E-033.4430E+02
6.1998E-033.4772E+025.5995E-033.5117E+022.2122E-023.5466E+025.5892E-033.5819E+02
3.3720E-033.6175E+023.2622E-033.6534E+021.1564E-033.6897E+023.0496E-033.7264E+02
2.9476E-033.7634E+022.8502E-033.8009E+025.5189E-033.8386E+023.0060E-033.8768E+02
2.7808E-033.9153E+022.6207E-033.9542E+022.4946E-033.9935E+022.3762E-034.0332E+02
2.6109E-044.0739E+022.0948E-044.1138E+021.9930E-044.1347E+021.9163E-044.1960E+02
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2.8817E-044.4086E+022.3976E-044.4525E+022.2027E-044.4967E+022.0393E-044.5414E+02
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1.3848E-044.7716E+021.3285E-044.8190E+021.2726E-044.8569E+021.2298E-044.9153E+02
1.8039E-044.9642E+021.5725E-055.0195E+021.4499E-055.0633E+021.3496E-055.1136E+02
1.2651E-055.1645E+021.5722E-055.2158E+021.0744E-055.2676E+021.0268E-055.3200E+02
9.8900E-045.3729E+025.5251E-055.4263E+024.8939E-055.4802E+022.5304E-055.5346E+02
1.7127E-055.5897E+021.4422E-055.6452E+023.3033E-055.7013E+021.1941E-055.7580E+02
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7.9771E-046.0499E+021.1943E-036.1100E+021.6918E-036.1707E+022.2347E-036.2320E+02
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LETFILE 7 90 PC WORST CASE(REV)
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4.925E 04 1.678E 00 2.556E 04 1.695E 00 1.851E 04 1.713E 00 1.421E 04 1.731E 00
1.324E 04 1.750E 00 1.109E 04 1.768E 00 2.428E 04 1.787E 00 6.042E 03 1.806E 00
5.399E 03 1.825E 00 5.516E 03 1.845E 00 5.220E 03 1.864E 00 5.220E 03 1.884E 00
4.760E 03 1.904E 00 4.551E 03 1.924E 00 4.551E 03 1.944E 00 3.813E 03 1.963E 00
3.718E 03 1.986E 00 3.718E 03 2.007E 00 3.415E 03 2.028E 00 3.245E 03 2.049E 00
3.245E 03 2.071E 00 3.106E 03 2.093E 00 2.462E 03 2.115E 00 2.462E 03 2.137E 00
2.462E 03 2.160E 00 2.457E 03 2.183E 00 2.081E 03 2.206E 00 2.081E 03 2.229E 00
2.081E 03 2.253E 00 2.081E 03 2.277E 00 1.855E 03 2.301E 00 1.710E 03 2.325E 00
1.710E 03 2.350E 00 1.710E 03 2.373E 00 1.710E 03 2.400E 00 1.359E 03 2.426E 00
1.321E 03 2.451E 00 1.321E 03 2.477E 00 1.321E 03 2.503E 00 1.321E 03 2.530E 00
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1.026E 03 2.667E 00 1.026E 03 2.695E 00 1.008E 03 2.723E 00 1.008E 03 2.752E 00
1.008E 03 2.781E 00 1.008E 03 2.811E 00 9.313E 02 2.841E 00 6.288E 02 2.871E 00
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6.288E 02 3.024E 00 5.137E 02 3.058E 00 5.069E 02 3.090E 00 5.069E 02 3.123E 00
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2.807E 02 3.581E 00 2.807E 02 3.619E 00 2.807E 02 3.657E 00 2.807E 02 3.696E 00
2.475E 02 3.735E 00 1.879E 02 3.775E 00 1.879E 02 3.815E 00 1.879E 02 3.855E 00
1.879E 02 3.896E 00 1.879E 02 3.937E 00 1.879E 02 3.979E 00 1.879E 02 4.021E 00
1.730E 02 4.064E 00 1.691E 02 4.107E 00 1.691E 02 4.150E 00 1.691E 02 4.194E 00
1.691E 02 4.239E 00 1.691E 02 4.284E 00 1.346E 02 4.329E 00 1.016E 02 4.375E 00
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